NON-PUBLIC?: N
ACCESSION #: 8912260001
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Trojan Nuclear Plant PAGE: 1 OF 7

DOCKET NUMBER: 05000344

TITLE: Reactor Trip on Over Temperature Delta Temperature Signal
EVENT DATE: 08/09/89 LER #: 89-017-01 REPORT DATE: 12/15/89

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 050

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On August 9, 1989 at 1220 hours the Plant was operating at 50 percent power when a reactor trip signal was generated, The reactor tripped when the logic for Over Temperature Delta Temperature (OT Delta T) was satisfied from a spurious signal. The other signal completing the two out of four logic was already being generated in Channel 3 of the OT Delta T logic due to the performance of Periodic Instrumentation and Control Test (PICT) 11-1, "Nuclear Instrumentation, Power Range". The trip was caused by receipt of a spurious signal, apparently from Channel 4 of the OT Delta T circuit. The signal was considered spurious because Reactor Coolant System conditions were acceptable when the trip occurred. A comprehensive investigation was conducted with no exact cause identified. However, the continued investigation did identify conditions which could have caused a spurious signal. These conditions included intermittent failure of a comparator module or an intermittent open in a termination connection which generated a transitory signal large enough

to cause the bistable to trip. A potential contributing factor was a lower OT Delta T setpoint than in previous operating cycles. Immediate corrective actions prior to return t
power included replacement of three
Channel 4 OT Delta T modules (even though no indication of failure existed) and performance of PICTs for inputs into all four of the OT Delta T channels. Corrective action included cleaning instrument cabinets, correcting problems with wiring terminations, implementing periodic cleaning of instrumentation cabinets and training of technicians on terminating connectors, and increasing the OT Delta T safety limit. Because the reactor tripped and all systems responded to the trip signal as designed, this event did not have any effect on public health and safety.

END OF ABSTRACT

DESCRIPTION OF OCCURRENCE

On August 9, 1989 at 1220 hours the Plant was operating at 50 percent power with Reactor Coolant System (RCS) conditions at 2235 psig and approximately 570 degrees Fahrenheit, when a reactor trip signal was generated. The reactor tripped when the logic for OT Delta T was satisfied from an apparently spurious signal, with one channel under test and already tripped. OT Delta T was verified as the originating trip signal on the sequence of events recorder.

The logic for the OT Delta T trip was partially satisfied because Channel 3 was in the test bypass mode with its bistable tripped. A signal was being intentionally generated in Channel 3 by an Instrumentation and Control (I&C) technician during the performance of actions required in Periodic Instrumentation and Control Test (PICT) 11-1, "Nuclear Instrumentation, Power Range".

All required equipment was in operation after the reactor trip signal, including the centrifugal charging pump, the component cooling water pumps, the service water pumps, the auxiliary feedwater pumps, and feedwater isolation.

The OT Delta T trip provides core protection to prevent the occurrence of Departure from Nucleate Boiling (DNB). The OT Delta T setpoint calculation is a function of the existing RCS average coolant temperature (Tave), the temperature difference between the hot leg (Th) and the cold leg (Tc), a core axial flux comparison, and pressurizer pressure, all compared to the same parameters at rated thermal power. RCS conditions

at the time of the trip were acceptable and the OT Delta T signal was not required for reactor protection.

The exact source of the OT Delta T signal that actually tripped the reactor is not known. Based on indications, previous spurious signals, and monitoring during current power operations, it is speculated the signal was received on Channel 4. Significant pre-trip indications and signals are described below.

At approximately 0255 hours, nine hours previous to the reactor trip, PICT 6- 4, "Reactor Delta Temperature and Average Temperature, Protection Set IV", was completed for Channel 4. The calibration checks were satisfactory. Shortly thereafter, at approximately 0302 hours, while inputting data from Periodic Engineering Test (PET) 13-2, "Reload Cycle 12 No Load and at Power Physics Tests", the Plant P250 computer received both a High OT Delta T (0256 hours) and a OT Delta T Setpoint alarm (0302 hours) on Channel 4. The spurious signals were noted at shift turnover. The Plant P250 computer also received a OT Delta T Setpoint alarm (1059) on Channel 2. These signals did not occur again prior to the reactor trip.

The OT Delta T recorder selected to Channel 4 shows a negative spike on the OT Delta T setpoint at approximately the time of the trip. The timing of this spike tends to support the assertion that channel 4 caused the trip.

The post-trip sequence of events also included receipt of a feedwater isolation signal (FWIS). The FWIS occurred, as expected, on a low Tave signal with a reactor trip. After isolation, the FW system response included: (1) The Main Feedwater Pump (MFP) suction relief valve sticking open, (2) The MFP continuing to operate, and (3) A pipe support had two "slipped" base plate fasteners and the condensate demineralizer vessels developed leaks on 5 out of 8 vessel heads.

CAUSE OF OCCURRENCE

The sequence of events recorder indicates that the OT Delta T signal was the initiating signal for the reactor trip. This was a spurious signal and appears to have originated from OT Delta T Channel 4. The negative spike on the Channel 4 OT Delta T recorder, at approximately the same time, and other observed behavior later, tends to confirm this.

An investigation was conducted which included an evaluation of: (1) As-found status of Channel 4 Delta T circuitry, (2) Pre/Post-trip

performance of all four Delta T channels, (3) The lowering the OT Delta T reactor trip setpoint for cycle 12 operation by a Technical Specification amendment, and (4) Other potential trip causes. A specific cause of the trip could not be identified from these evaluations. The conclusion was that an apparently spurious signal caused the trip, Further investigation after returning to power included installing recorders to monitor the OT Delta T trip signals, as well as identifying and evaluating other possible contributors to the trip. The methodology used for the evaluation and the continued investigation are summarized below.

(1) As-found status of Channel 4 Delta T circuitry.

The initial check of the as-found condition included performing the necessary parts of PICT 6-4. All calibration checks were satisfactory. Various loop test points were monitored while conducting the PICT with no identified deficiencies. (The same points were monitored again from August 10 to August 11 with sealed cabinets to evaluate cabinet temperature effects - again, no abnormal indications were observed.)

The signal summators module was removed for a bench checkout. The module was alternately heated and cooled while being monitored. Again, all indications were satisfactory.

To consider the potential for loose wiring associated with the Channel 4 Delta T circuit, the cables and wiring were inspected. No abnormal indications were identified.

(2) Pre/Post-trip performance of all four Delta T channels. Instrument readings and calculated values associated with the Delta T channels were reviewed on the P2500 computer. No abnormalities were detected.

The evaluated information included:

Pre/Post trip trends with a duration from minus 120 minutes to plus 30 minutes at 1 minute intervals and from minus 5 minutes to plus 5 minutes at 10 second intervals. The evaluated trends included those for neutron monitors (N41, N42, N43, and N44), Delta Flux, Delta T, and pressurizer pressure (loops 1, 2 and 4).

Pre-trip four hour trends at one minute intervals for neutron monitors, Th and Tc, Delta T, and pressurizer pressure (loops 1, 2, and 4).

Pre-trip eight day trends at one hour intervals for min/max levels of neutron monitors, Th and Tc, Delta Flux, and pressurizer pressure (loops

1, 2, and 4).

To address possible trends in equipment failures a review of equipment history was conducted. No abnormal trends identified.

The PICTs for all four Delta T channels had been recently revised. These procedures were reverified and validated. Nothing which would have contributed to the trip was found during this process.

(3) Lowering the OT Delta T setpoint.

Another factor to be considered is non-hardware related; the plant setpoint for OT Delta T was recently changed to a lower value. Having the setpoint at a lower value, closer to nominal operating values, accounts for part of the problem. The lower value causes peaks in channel noise to be closer to the setpoint values. Spikes in the noise can exceed the rod block alarm, and if large enough, cause the associated bistable to trip.

The spurious signals continued to occur while operating at 97 percent power. Since a loose connector on the Channel 4 Tave lead/lag module was replaced, the bistable has not tripped, and computer alarms have ceased.

(4) Other potential trip causes.

Plant recorders for other plant parameters were reviewed for real or spurious trip indications. No abnormal sources were found during the initial investigation. The continued investigation, discussed in (5) below, did identify potential sources of a spurious OT Delta T signal. An independent review of potential trip factors was conducted by Nuclear Plant Engineering personnel. No additional indications were identified.

Two I&C technician crews were interviewed to discuss work in progress. Their actions were documented and reviewed. No actions were identified as contributing to the trip.

The possibility of radio transmission as a spurious signal was considered. No use of radios inside the control room were identified during the time period of interest.

(5) Continued Investigation

The continued investigation involved monitoring all four OT Delta T channels for spurious signals. This monitoring did not identify a

spurious signal source, but it aided in identifying that a module was not correctly installed.

On August 28, the connector to the Channel 4 Tave lead/lag module was found to be broken and was replaced. This broken connector condition existed on the replacement module (for the module removed for bench testing after the trip) and contributed to spurious alarms after the trip but it was not a cause of the trip.

Three modules removed from the Channel 4 OT Delta T instrument loop (lead/lag, summators, and comparator) were benched tested for approximately thirty days after the trip. The results of this testing showed an intermittent spike in both outputs of the comparator module with no indicated input variation. The interval was determined to be random and the magnitude of the spike varied from 10 to 60 VAC. Both the amplitude and frequency of the spikes appeared to increase when adjustments on the channel were made to simulate the performance of surveillance testing. In addition, while conducting the simulated surveillance, it was observed that each output (but primarily the output to the Solid State Protection System) would reset to approximately one half of the normal output voltage as the setpoint adjustment of the comparator module was being returned to its normal position. This phenomenon would last from a few seconds to several minutes before voltage returned to normal. This apparent source of a signal spike was traced to a problem
ith the power supply used for the bench testing.

During the investigation, problems were identified with some termination connections not being tight and open fork spade lug connections found with one side of the spade free of the termination screw. The cleanliness of the cabinets in which the modules are located was also identified as a potential source of the trip signal. Dust/dirt in a connection can cause a high resistance or an intermittent connection in a signal path.

The continued investigation concluded that the most likely source of the second signal which satisfied the OT Delta T reactor trip logic! was an intermittent open in Channel 4 which generated a transient signal of sufficient magnitude to cause a trip. A contributing factor was a lower OT Delta T setpoint than in previous operating cycles.

During the evaluation no previous reactor trips were identified as being similar.

FW System Response

The relief valve failure, "slipped" fasteners and demineralizer vessel head leaks occurred after the FWIS and affected the portion of the FW system isolated from the steam generators. The FV system challenges did not affect the operation of safety related systems.

The MFP suction relief valve was determined to have lifted because of the normal pressure surge caused by the closure of the FW regulating valves upon receipt of the FWIS. The valve stuck open due to multiple valve part failures caused by corrosion and vibration damage.

The MFPs did not trip because the pressure surge was not high enough to reach the high discharge pressure trip.

The pipe support fasteners "slipped" approximately 1/16" and the demineralizer vessel heads leaked as a result of the pressure surge. The support was originally installed to reduce movement of the line during dynamic loading. It is not uncommon for a small amount of slippage and leakage to occur due to dynamic loads.

CORRECTIVE ACTIONS

Immediate corrective action to prevent recurrence included replacement of three OT Delta T modules which could contribute to a spurious signal. These were replaced even though there was no indication they were the source of the spurious signal. The replaced modules included the OT Delta T summator, the Tave lead/lag module and the trip bistable comparator.

An additional immediate corrective action was to verify operability of all four channels of OT Delta T, pressurizer pressure, and power range detectors by performing their associated PICTs.

An intermediate term corrective action involved fixing the Channel 4 Tave lead/lag module connector, after it was found to be broken on August 28. (The bad connector was on the replacement module, not the module in place when the reactor tripped, and fixing it helped to correct the spurious alarms which had been received after returning to power.)

To try to restore some extra margin between operating conditions and the new setpoint the following actions have been taken: (1) Recalibrated RCS Delta T, the core axial flux comparison, and the resistance to current curve for Channel 4 Th and Tc, (complete), (2) Contacted Westinghouse for OT Delta T safety limit extension and/or a tradeoff with other setpoints, and (3) Evaluated electronic noise sources.

Westinghouse extended the safety limit for OT Delta T and the process to change the setpoint is in progress (CTL # 31232). The evaluation of noise sources determined the noise level is similar to or less than other Westinghouse plants. Westinghouse also confirmed that the 1 to 4 degrees F variation in the RCS temperature signals is within the normal process variation range.

The identified conditions of dust/debris in the cabinets, loose connectors or terminations, and open fork spade lugs with one fork not engaged have been corrected through cleaning of the cabinets and inspecting connectors/terminations for correct installation and adjusting them as necessary.

To reduce the probability of these types of problems recurring, a cleaning and inspection program will be developed, by March 1, 1990, for these cabinets and other electronic instrument racks (all control room racks and selected racks in other plant locations) (CTL 31808). Training will be provided for electricians and technicians, by March 1, 1990, in the correct method of terminating connections and mounting methods for modules in the instrument racks (CTL #31807).

The MFP suction relief valve was repaired and will be placed in the preventative maintenance program by March 21, 1989 (CTL #31233) to prevent recurrence. The pipe support fastener bolts were retightened and the leaks on the condensate demineralizer were repaired.

SIGNIFICANCE OF OCCURRENCE

Because the reactor tripped and all systems responded to the trip signal as designed, this event did not cause a significant degradation of operational safety nor did it have any effect on public health and safety.

PGE
December 19, 1989
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Trojan Nuclear Plant
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U.S. Nuclear Regulatory Commission
Document Control Desk
Washington DC 20555

Gentlemen:

Licensee Event Report No. 89-17, Revision 1, is attached. This report updates an event in which a reactor trip occurred due to a spurious Over Temperature Delta Temperature signal.

Sincerely,

C. P. Yundt
General Manager
Trojan Nuclear Plant

c: Mr. John B. Martin
Regional Administrator, Region V
US Nuclear Regulatory Commission

Mr. David Stewart-Smith
State of Oregon
Department of Energy

Mr. R. C. Barr
USNRC Resident Inspector
Trojan Nuclear Plant

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